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L5	L1 and (ink jet or inkjet or ink-jet)	155	L5
L4	L2 not l3	9	L4
L3	L2 and (ink jet or inkjet or ink-jet)	6	L3
L2	L1 and (porous (organic or polymeric) particles)	15	L2
L1	((polyvinyl alcohol) or pva or (poly vinylalcohol) or (poly vinyl alcohol) or polyvinylalcohol or (polyvinyl alcholo)) with (saponification or saponified or hydrolysis or hydrolysed or hydrolyzed) with (molecular weight)	2048	L1

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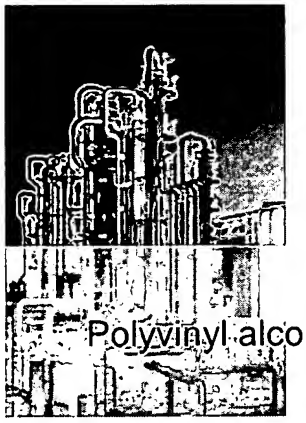
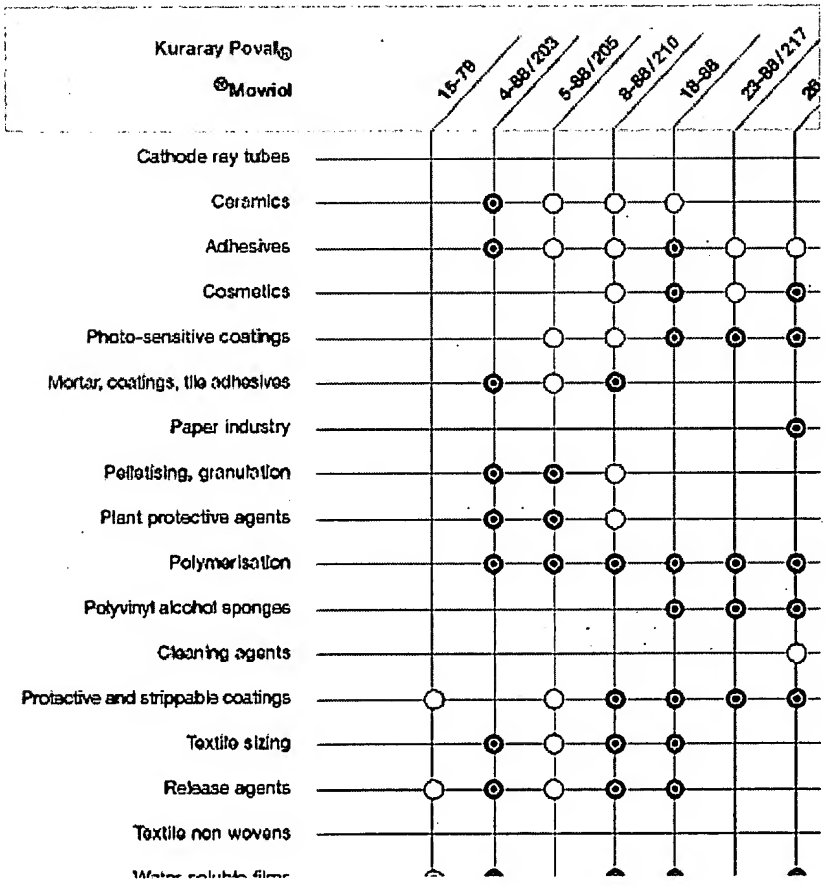
Specialized in Specialities



Polyvinyl alcohol – champion in versatility

Partially hydrolysed grades

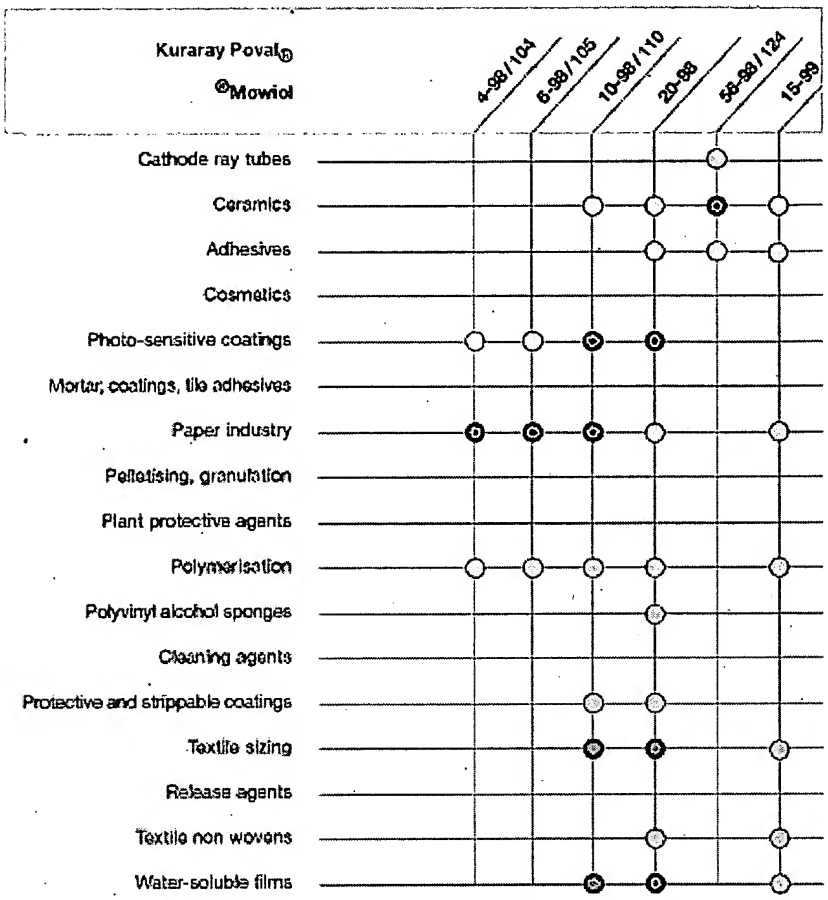
Polyvinyl alcohols contain vinyl alcohol and vinyl acetate units. In part hydrolysed grades the vinyl alcohol content is such that the entire mo freely soluble in water.



Water-soluble films

Fully hydrolysed grades

A high degree of hydrolysis increases the crystallisation tendency and crystallinity of polyvinyl alcohols. Fully hydrolysed grades are therefor soluble in water.



◉ Main applications area
○ Possible application area

Download Application Tableau

Each column in the table shows grades with comparable application p specification parameters (degree of hydrolysis and viscosity).

Download Technical Datasheet Poval
Download Technical Datasheet Mowiol

KSE
Kuraray Specialities Europe

Kuraray Poval®

Technical data sheet

Characteristics

Polyvinyl alcohol (PVA) grades with varying degrees of polymerisation and hydrolysis.

Recommended uses

Modification of emulsion adhesives, production of paper adhesives and re-moistenable adhesives. Protective colloid in emulsion polymerisation and raw material for the production of sizes and textile finishes. Binder in the surface finishing of paper. Also for regulating the processing characteristics of all types of coatings.

Delivery form

Granules, if not specified otherwise.

Data

The data are determined by quality control for each lot prior to release.

	Kuraray Poval® grade type	Viscosity[1] JIS K 6726 mPa·s	Degree of hydrolysis (saponification) mol %	Max ash content[2] %
Partially hydrolysed grades	PVA 203	3.4 ± 0.2	88.0 ± 1.0	0.4
	PVA 205	5.0 ± 0.4	87.8 ± 1.3	0.4
	PVA 205MB[3]	5.0 ± 0.4	87.8 ± 1.3	0.4
	PVA 205S[3]	5.0 ± 0.4	87.8 ± 1.3	0.4
	PVA 217	22.5 ± 2.0	88.0 ± 1.0	0.4
	PVA 217SB[3]	22.5 ± 2.0	88.0 ± 1.0	0.4
	PVA 217S[3]	22.5 ± 2.0	88.0 ± 1.0	0.4
	PVA 220	30.0 ± 3.0	88.0 ± 1.0	0.4
	PVA 220SB[3]	30.0 ± 3.0	88.0 ± 1.0	0.4
	PVA 220S[3]	30.0 ± 3.0	88.0 ± 1.0	0.4
	PVA 224	44.0 ± 4.0	88.0 ± 1.0	0.4
	PVA 224SB[3]	44.0 ± 4.0	88.0 ± 1.0	0.4
	PVA 224S[3]	44.0 ± 4.0	88.0 ± 1.0	0.4
	PVA 226	54.0 ± 4.0	87.5 ± 1.5	0.4
	PVA 235	95.0 ± 15.0	88.0 ± 1.0	0.4
	PVA 403	3.1 ± 0.3	80.0 ± 2.0	0.4
	PVA 405	4.8 ± 0.4	81.5 ± 1.5	0.4
	PVA 420	41.0 ± 4.0	79.5 ± 1.5	0.4
Medium hydrolysed Grades	PVA CST	27.0 ± 3.0	96.0 ± 0.5	0.4
	PVA 613	16.5 ± 2.0	93.5 ± 1.0	0.4
	PVA 624	55.0 ± 5.0	95.5 ± 0.5	0.4
	PVA 706	7.0 ± 0.7	91.5 ± 1.0	0.4
Fully hydrolysed Grades	PVA 103	3.5 ± 0.3	98.5 ± 0.5	0.7
	PVA 105	5.6 ± 0.4	98.5 ± 0.5	0.7
	PVA 105K[3]	5.6 ± 0.4	98.5 ± 0.5	0.7
	PVA 110	11.0 ± 0.8	98.5 ± 0.5	0.7
	PVA 117	28.5 ± 3.5	98.5 ± 0.5	0.4
	PVA 117K[3]	28.5 ± 3.5	98.5 ± 0.5	0.4
	PVA 117S[3]	28.5 ± 3.5	98.5 ± 0.5	0.4
	PVA 117H[3]	29.0 ± 3.0	≥ 99.3	0.7
	PVA 124	60.0 ± 0.3	98.5 ± 0.5	0.4

[1] of a 4 % aqueous solution at 20 °C, determined by Brookfield synchronised-motor rotary-type viscometer

[2] calculated as Na_2O

[3] K, MB, SB: anti-foaming/defoaming grade; S: finer powder grade; H: super-hydrolysed

Published in November 2002

Additional data, valid for all Kuraray Poval® grades

Volatile content max. 5 % (based on measurement in packaging).

Methanol content: less than 3 %.

pH of a 4 % solution in distilled water: 4.5 - 7.

The viscosity of the 4 % aqueous solution at 20 °C is a relative measure for the molar mass of the PVA grade; the mentioned degree of hydrolysis denotes the degree of hydrolysis of the polyvinyl acetate from which the PVA grade is derived. There is a subdivision into "partially hydrolysed", "medium hydrolysed" and "fully hydrolysed" grades.

K-, MB-, and SB-grades are Poval types pre-treated with an anti-foaming agent.

S-grades are finer powder grades (80-100 mesh pass).

Properties and uses

Polyvinyl alcohols (PVA) are water-soluble polymers manufactured by alcoholysis of polyvinyl acetate.

The properties of the various grades are mainly governed by the molecular weight and the remaining content of acetyl groups.

Because polyvinyl alcohols have such good cohesion and good adhesion to fibres, fillers and pigments, all grades are notable for their good bonding strength and pigment binding capacity. The latter intensifies with increasing molecular weight; in the case of Poval expressed by the viscosity of a 4 % aqueous solution.

This, together with the adhesive/cohesive strength and with a number of other specific properties, allows the manufacture of unfilled to highly filled systems for a variety of uses.

Properties of PVA films

The properties of PVA films are governed mainly by the grade of Poval used.

The water resistance of dried PVA-based films increases with increasing molecular weight and degree of hydrolysis. It can be improved still further by heat-treating the dried film at a temperature of, for instance, 120 °C. Another possible way of improving the water resistance is to add acids such as orthophosphoric acid or salts such as ammonium chloride, sodium bichromate or ammonium bichromate in the solution in a quantity of 5 % by weight, relative to the PVA. Other products that can be used to increase the water resistance are aldehydes such as formaldehyde or glyoxal, and also urea-formaldehyde resins and melamine-formaldehyde resins in quantities of 10 - 20 % by weight relative to the PVA.

Ultraviolet radiation on the dried PVA film also enhances water resistance.

Plasticizers for PVA are polyhydric alcohols e.g. glycerol, neopentyl glycol, trimethylol propane, ethylene glycol, di- and triethylene glycol and polyethylene glycols up to a molecular weight of approximately 400 and in quantities of up to 30 % by weight, relative to the PVA.

PVA as an adhesive raw material

PVA is used in a similar manner as natural products such as casein as well as starch and its degraded derivatives (for example dextrins) as raw material for the production of aqueous adhesive solutions.

Compared to dextrins and casein PVA has the advantage of a more uniform chemical structure and greater adhesion, being obtained with minimum raw material requirements.

Water-activated adhesives

Remoistenable adhesives are employed mainly in the paper processing industry. Very familiar uses are the gumming of paper on the reverse side (e.g. postage stamps and labels) and the application of gum to the flaps of envelopes and "Jiffy"-type bags. Partially hydrolysed PVA grades with low to medium viscosity, e.g. Kuraray Poval PVA-205 MB are particularly suitable for this function. To produce the adhesive, PVA solutions of up to 30 % are applied according to the viscosity requirements, these solutions containing defoamer (MB, SB types), addition of preservative is recommended.

Drying of the adhesive can be accelerated by adding alcohols. The drying temperature must be as low as possible and on no account exceed 130 °C, since otherwise this will make the gummed surface more difficult to be activated.

The open time of the adhesive depends on the grade of PVA employed. Increasing viscosity of a 4 % PVA solution is generally accompanied by decreasing open time.

An applied quantity of some 10 g Poval PVA-203 solid per m² allows the production of coatings with very good remoistening properties and the following advantages:

- high degree of flatness during storage under fluctuating air humidity
- colourless, flexible coatings
- minimal blocking tendency, even in high air humidity
- fast setting after reactivation

Wet bonding

Higher-viscous and fully hydrolysed polymers such as Poval PVA-117 and Poval PVA-124 are preferred if the adhesives are intended for the production of bonds resistant to cold water. These are used for such applications as the manufacture of special paper laminates (cardboard), spiral tubes and sealing materials for packaging. Usually these PVA grades also possess higher "wet tack".

Aqueous adhesives based on PVA can also be extended with fillers such as china clay. Even with ratios of approx. 2 parts by weight of filler to 1 part by weight of PVA it is still possible to obtain firm bonds in the winding of spiral tubes or the plane-surface bonding of paper and cardboard.

Modification of emulsion adhesives

Aqueous solutions of PVA can be added to polymer emulsions already stabilized with polyvinyl alcohol. This effects

- extension of the open time
- increase of the setting speed
- influence on the rheology.

The open time is very important in such operations like the manual or machine bonding of wood and paper.

In a number of polymer emulsions the addition of PVA solution increases the

bonding speed considerably. Additions of up to 10 % of an approx. 15 % solution of PVA to the polymer emulsion have proved to be suitable for this purpose.

The choice of PVA grades is primarily dependent on the viscosity required in the ready-to-use adhesive.

Generally speaking, preference should be given to partially hydrolysed PVA grades on account of their faster solubility at lower temperatures.

In emulsion adhesives suitable for application by dip wheel or roller-on applicator machines the addition of PVA solutions has the advantage of largely preventing skin formation during processing.

The combination of PVA grades with cellulose-stabilised polyvinyl acetate emulsions is also possible, but storage stability needs to be checked.

PVA as protective colloid

PVA grades, preferably of the partially hydrolysed range, are used as protective colloids in the polymerisation of polymer emulsions. Because of their ability to anchor to the surface of the polymer particles that form, they help to stabilise the polymer emulsion during and after polymerisation. Those PVA types influence not only particle size distribution but also the application properties such as viscosity, stability to stirring, the freeze/thaw stability, pigment compatibility, electrolyte stability and open time of the emulsion.

PVA as binder in textile sizes

The use of PVA as a binder in sizes is based on its good penetration capacity and good adhesion properties on all types of fibrous material. The excellent film characteristics of PVA like high cohesion and toughness, low electrostatic charging and redissolving capacity of the dried film in water complete the characterisation of this polymer as suitable agent for this purpose.

PVA as a versatile auxiliary aid in paper applications

Due to its broad property profile PVA is frequently used as a co-binder in paper coatings. The particular suitability of PVA in pigmented coatings is based on its

- outstanding carrier properties to optical brightening agents
- excellent colloidal protection becoming effective in high solids pigment formulations which establishes a smooth viscosity profile
- good water retention in coating colours
- high binding strength in paper coatings which can be related to polymer cohesion as well as to good adhesion to the fibre and to the pigment particles, respectively.

Low molecular weight PVA grades such as Poval PVA-103 and Poval PVA-105 are the preferred polyvinyl alcohols to be used in paper coatings.

PVA possesses remarkable barrier properties. Due to its insolubility in most organic solvents surfaces treated with PVA repel hydrophobic products such as oil, grease and fat. Furthermore, PVA displays excellent mechanical strength properties if applied as a film on paper or paperboard. Therefore it fits well as a surface sizing agent. Many special paper grades are produced using PVA, such as

- silicon base paper, to be used as release paper for pressure sensitive adhesive (PSA) labels
- banknote paper and grades with high folding endurance
- thermoreactive paper for e.g. bar code labels or facsimile machines
- film casting (release) paper
- ink-jet paper.

Processing

Preparation of PVA solutions

In the adhesives sector PVA is processed as an aqueous solution, as it is in most other fields of application. The solution should be prepared in corrosion-resistant vessels.

As a first step PVA is sprinkled into cold water during stirring and heated to 90 - 95 °C in a water bath or by the use of live steam.

The solution should be stirred during cooling in order to prevent skin formation.

The partially hydrolysed PVA grades dissolve in water much faster than the fully hydrolysed grades. The speed of dissolution increases with increasing temperature. For both partially and fully hydrolysed PVA grades the speed of dissolution decreases with increasing molecule size (i.e. increasing viscosity of the 4 % aqueous solution). The dissolving process is also made more difficult when there is a transition to higher concentrations. As a result, even a more highly concentrated PVA solution, e.g. a 30 % solution of Poval PVA-203, should be produced at temperatures of 90 -95 °C.

Polyvinyl alcohol solutions may produce foam when stirred or during transport in pipelines, but this can be largely prevented by using a suitable stirrer design such as a low-speed anchor stirrer or by avoiding steep downward gradients in the pipelines.

Suitable defoamers are n-octanol, tributyl phosphate, Dehydran 132[1] and the Agitan grades[2] 290, 305 and 731, which are used in quantities of up to approx. 0.1 % relative to the solution. Additionally, pre-treated anti-foaming/defoaming types (K, MB, SB types) are also available.

Polyvinyl alcohol solutions which have been stored for lengthy periods may increase in viscosity. This is especially true of fully hydrolysed grades in high concentrations and at low temperatures. The original viscosity can be restored by heating and stirring.

Preservation

PVA in the form of an aqueous solution can be attacked by micro organisms under certain conditions. In the acidic pH range the main organisms reproduced are the fission fungi, while bacteria grow most readily in a neutral to weakly alkaline medium.

The solution can be preserved from any micro organism attack by adding a preservative. Products which have proved especially suitable for the purpose are for example the Mergal grades[3] K9N and K14. The dosage depends on the concentration of the solution, the storage temperature and the nature and intensity of the infection. Quantities of about 0.01 - 0.2 % by weight preservative, relative to the PVA solution, are generally sufficient. Compatibility and efficiency must be tested. Information on the quantity to be used is available from the suppliers.

It is advisable for the PVA solution to be prepared and stored in clean containers. Considering the resistance that may be shown by some micro organisms to the preservatives employed, the dissolving vessel in particular, together with the filling equipment (pipes, valves, tubing etc.), needs to be kept clean. Any skins or incrustations should be removed. In the event of complications the possibility of changing to a different preservative must be considered.

Certain applications for PVA in solution (cosmetic preparations, finger paints etc.) require the preservatives employed to be of approved types and physiologically inert. In such instances it is essential for the relevant legal regulations regarding physiological effects to be taken into account.

Storage

PVA can be stored for an unlimited period of time under appropriate conditions that is in its original packs in closed, dry rooms, at room temperature.

Industrial safety and environmental protection

Not classified as a dangerous substance or preparation according to the current criteria of chemical legislation, or of the EU Directives 67/548/EEC and 1999/45/EEC.

A safety data sheet is available on request.

Special remarks

Status as governed by foodstuffs legislation

According to various recommendations of the Bundesinstitut für Risikobewertung (German Federal Institute for Risk Assessment), BfR, Polyvinyl alcohol can be used in the production of essential commodities within the meaning of the German Foodstuffs and Essential Commodities Law, § 5, and of the US Code of Federal Regulations, title 21, food and drugs.

Examples are the German Federal Health Office Recommendations II, Plasticizer-free PVC, XIV, Synthetic resin emulsions, and XXXVI, Paper and cardboard in contact with foodstuffs, considering the limitations mentioned therein concerning quantities and viscosity.

Polyvinyl alcohol is also sanctioned by the EC plastics directive 2002/72/EC (all monomers and starting substances authorised by listing in Annex II, Section A) as well as by Council of Europe, Resolution AP 96(5) on surface coatings intended to come into contact with foodstuffs - (all monomers and starting substances authorised by listing in appendix II, list 1).

Examples for FDA are the §§ 175.105 Adhesives, 175.300 Resinous and polymeric coatings, 176.170/176.180 Components of paper and paperboard in contact with aqueous and fatty foods/with dry food, 177.1670 Polyvinyl alcohol film.

Because of their low viscosity the grades PVA-103, PVA-203, PVA-205, PVA-205 MB, PVA-205 S, PVA-403, and PVA-405 in the fields of application mentioned above can only be used to a limited extent or not at all.

[1] Henkel KGaA, Düsseldorf, Germany
[2] Münzing Chemie GmbH, Heilbronn, Germany
[3] Troy Corp., Seelze, Germany

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